RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #14

Version 0.2 of the Draft of Appendix N: Proposed DO-260A Provisions for Backward Compatibility with DO-260 Message Formats

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Summary

DO-260A will include a number of changes to the Extended Squitter ADS-B Message formats. 1090 MHz Extended Squitter receivers built and certified against DO-260A will need to interoperate with ADS-B Transmitting Subsystems that are broadcasting ADS-B Messages in the ADS-B Version 0 format defined by DO-260. Since DO-260A will replace DO-260, the definition of the ADS-B Version 0 messages will need to be retained within DO-260A. This working paper is an update to WP13-03.

References:

1. DO-260, MOPS for 1090 MHz ADS-B, Sept. 2000
2. DO-260A, working draft, August 2002
3. WP13-03, Proposed New Appendix N (first draft)

1. Introduction

DO-260A will include a number of changes to the extended squitter ADS-B message formats. 1090 MHz extended squitter receivers built and certified against DO-260A will need to inter-operate with ADS-B systems that are broadcasting ADS-B messages in the ADS-B Version 0 format defined by DO-260. Since DO-260A will replace DO-260, the definition of the ADS-B Version 0 messages that must be decoded and used by the report assembly function of a Version 1 receiving system will need to be retained within DO-260A, at least at a minimal level.

2. Proposal

Attachment 1 to this working paper proposes a number of changes within section 2.2 of the MOPS to require backward compatibility with ADS-B Version 0 messages. Attachment 2 to this working paper proposes a new Appendix N that would define the format of the ADS-B Version 0 messages that must be supported by a Version 1 1090 MHz ADS-B receiver. Note that TCP and Operational Coordination Messages, as defined by DO-260, are not required to be used by Version 1 receivers as they are not used for report generation as per draft DO-260A and DO-242A.

ATTACHMENT 1

Proposed DO-260A Changes to require interoperability with Version 0 messages

Para. 2.2.3.2.7.3.5 (Version Number subfield in Aircraft Operational Status Message) –

The "Version Number" subfield is a 3-bit ("ME" bits 41 through 43, Message bits 73 through 75) field used to indicate the Version Number of the formats and protocols in use on the aircraft installation. Encoding of the Version Number subfield shall be as shown in Table 2.2.3.2.7.3.5 (and in Table A-21 in Appendix A). Upon receipt of an Aircraft Operational Status Message (i.e., with a message type code of 31), ADS-B Receiving Subsystems conformant with this version of the 1090 MHz MOPS shall decode 'ME' bits 41 through 43 in order to determine the ADS-B Version to be used for the decoding of the remainder of the message. An ADS-B Version One (1) receiving subsystem shall initially assume that the message came from a Version Zero (0) ADS-B transmitting subsystem, until received Version Number data indicates otherwise.

The version determined from the decoding of the Version Number subfield of the Aircraft Operational Status message shall be retained and associated with the specific target. This version number shall then be used for determining the applicable message formats to be applied for the decoding of all subsequent 1090 MHz ADS messages received from that target.

Notes: 1. A summary of the DO-260 compliant, ADS-B Version Zero (0) message formats that must by received and processed by Version One (1) 1090 MHz ADS-B receiving systems is provided in Appendix N.

2. The Version One (1) Aircraft Operational Status message format includes an explicit Version Number subfield ("ME" bits 41-43). For an ADS-B Version Zero (0) Aircraft Operational Status message these same bits are unassigned and are required to be set to a value of Zero (binary 000). Thus in this latter case a Version One (1) 1090 MHz ADS-B receiving system will decode "ME" bits 41-43 to indicate a version number of Zero (0).

Table 2.2.3.2.7.3.5: Version Number Encoding in Aircraft Operational Status Message.

Value	MOPS Version	MASPS Version
0	DO-260	DO-242
1	DO-260A	DO-242A
2-7	Reserved for future growth	Reserved for future grown

Para. 2.2.9.1 (ADS-B Receiver Reporting Requirements for Class A Equipage) – Add a new second paragraph:

The report assembly function shall maintain backward compatibility with prior versions of the relevant 1090 MHz ADS-B messages (i.e., Airborne Position, Surface Position, Airborne Velocity, Aircraft Status, and Aircraft Operational Status, Identification and Type) that are used to as the basis to generate State Vector, Air Referenced Velocity and Mode Status Reports. The relevant Version Zero (0) message formats, conformant to DO-260, and their required use for ADS-B report generation are defined in Appendix N.

Para. 2.2.9.1.3 (ADS-B Target State Reports for Class A Equipage) – Add new third paragraph and a note:

c. Target State Reports for newly acquired target aircraft shall not be provided until or unless an Aircraft Operational Status Message (§2.2.3.2.7.2) has been received from the target aircraft indicating an ADS-B Version Number of other than Zero (0).

Note: Version Zero (0) messages that convey trajectory intent information using message type code 29 (see Appendix N) are not to be used by 1090 MHz ADS-B receiving systems conformant to this MOPS for the purpose of report generation. Therefore a positive determination that the applicable Version Number is other than Zero (0) for a received message with a type code of 29 is necessary in order to avoid errors in the reporting of the aircraft target state.

Attachment 2

Proposed new

Appendix N

Appendix N

ADS-B Report Assembly when Receiving Version Zero (DO-260) Extended Squitter Messages

N.1 Introduction

N.1.1 Purpose of this Appendix

This appendix:

a) defines the formats and coding for extended squitter ADS-B messages that are broadcast by ADS-B Version Zero (0), DO-260 conformant 1090 MHz ADS-B systems; and

b) defines how the ADS-B report generation function of Version One (1) 1090 MHz ADS-B receiving systems is to utilize messages received from targets that are broadcasting with Version Zero (0) message formats.

N.1.2 Message Version Number

The version number for all messages originating for each specific ADS-B target shall be determined from the decoding of the Version Number subfield of the Aircraft Operational Status message. An ADS-B Version One (1) receiving subsystem shall initially assume that the messages conform to Version Zero (0) message formats, until or unless received Version Number data indicates otherwise. The version number shall be retained and associated with all messages from that specific target. This version number shall be used for determining the applicable message formats to be applied for the decoding of all 1090 MHz ADS messages received from that target.

N.2 1090 MHz ADS-B Message Types

Table N-1 provides those ADS-B Version Zero (0) (i.e., originating from a DO-260 conformant 1090 MHz ADS-B system) 1090 MHz ADS-B messages that **shall** be used for ADS-B report generation by a Version One (1) conformant receiving system.

Note: Table N-1 lists only those Version Zero (0) 1090 MHz message types that are required to be received and used for ADS-B report generation by a Version One (1) 1090 MHz ADS-B receiving system. The other Version Zero (0) messages types defined by DO-260, including messages types 29 and 30, are not to be used by Version One (1) receiving systems for the purpose of ADS-B report generation.

Table N-1 Version Zero (0) ADS-B Message Types

Message Format Type Code(s)	Assignment	Nominal Broadcast Rate
9 through 18 and 20 through 22	Extended squitter Airborne Position	0.5 s
5 through 8	Extended squitter Surface Position	0.5 s in motion/5.0 s stationary
1 through 4	Extended squitter Identification and Type	5.0 s airborne/10.0 s surface
19	Extended squitter Airborne Velocity	0.5 s
28	Extended squitter Aircraft Status (e.g., emergency/priority)	1.0 s
31	Aircraft Operational Status	1.7 s

N.2.1 Message Type Codes

The first 5-bit field in every 1090 MHz ADS-B message contains the message format type. As shown in Table N-2, the TYPE code (i.e., format type) is used to differentiate the messages into several classes: airborne position, airborne velocity, surface position, identification, aircraft status, etc. The general definition for all messages types used for Version Zero (0) messages has been retained for Version One (1) messages. It must be noted for Version Zero (0) messages, format TYPE Code 29 was defined but the corresponding message were not to be transmitted. For Version Zero (0) systems, TYPE code 29 was associated with intent messages conveying Trajectory Change Point (TCP) information. Although the message formats for TCP related messages were defined within DO-260 the requirements and the associated test procedures prohibited the broadcast of such messages. DO-260 defined TYPE Code 30 for Operational Coordination messages. The requirements and associated provisions for Operational Coordination messages have now been withdrawn by this version of the this MOPS. Although DO-260 (i.e., Version 0) conformant implementations are not prohibited from transmitting Operational Coordination messages (i.e., using TYPE Code 30) Version One (1) conformant receiving systems have no requirement for the reception and processing of these broadcasts. Version One (1) receiving systems **shall** generate ADS-B reports based only on the reception of Version Zero (0) messages with Message TYPE Code values of 0 through 22, 29 and 31.

Table N-2 Format Type Codes for Version 0 and Version 1 Messages

Type Code	Version 0 Message Format	Version 1 Message Format
0	No Position Information	No Position Information
1	Identification (Category Set D)	Identification (Category Set D)
2	Identification (Category Set C)	Identification (Category Set C)
3	Identification (Category Set B)	Identification (Category Set B)
4	Identification (Category Set A)	Identification (Category Set A)
5	Surface Position	Surface Position
6	Surface Position	Surface Position
7	Surface Position	Surface Position
8	Surface Position	Surface Position
9	Airborne Position	Airborne Position
10	Airborne Position	Airborne Position
11	Airborne Position	Airborne Position
12	Airborne Position	Airborne Position
13	Airborne Position	Airborne Position
14	Airborne Position	Airborne Position
15	Airborne Position	Airborne Position
16	Airborne Position	Airborne Position
17	Airborne Position	Airborne Position
18	Airborne Position	Airborne Position
19	Airborne Velocity	Airborne Velocity
20	Airborne Position	Airborne Position
21	Airborne Position	Airborne Position
22	Airborne Position	Airborne Position
23	Reserved for Test Purposes	Reserved for Test Purposes
24	Reserved for Surface System Status	Reserved for Surface System Status
25	Reserved	Reserved
26	Reserved	Reserved
27	Reserved	Reserved for Trajectory Change
28	Extended Squitter Aircraft Status	Extended Squitter Aircraft Status
29	Reserved for Trajectory Intent	Target State and Status
30	Operational Coordination	Reserved
31	Operational Status	Operational Status

N.3 State-Vector Reports Generated using Version Zero (0) Messages

The following subparagraphs summarize the ADS-B State Vector Report generation requirements (see section 2.2.8.1) for Version One (1) systems when receiving Version Zero (0) messages.

The contents of State Vector Reports **shall** be as defined in Table 2.2.8.1. The contents of the State Vector Reports are composed primarily from the information received from airborne aircraft in Airborne Position messages and Airborne Velocity messages or for aircraft/vehicles on the airport surface in Surface Position Messages. Many of the parameters contained within these messages are encoded the same, and occupy the same positions with the overall message structure, for both Version Zero (0) and for Version One (1) messages. However, in a few cases the decoding and/or report assembly processing must be handled differently for Version Zero (0) messages as compared to that required by this MOPS (para. 2.2.8.1) for Version One (1) messages. The following subparagraphs describe the required use of Version Zero (0) messages for ADS-B report generation by a Version One (1) compliant receiving system.

N.3.1 State Vector Report to 1090 MHz ADS-B Message Mapping

Table 2.2.8.1 defines the overall State Vector Report format and the source for each parameter that is to be reported when the target aircraft/vehicle is broadcasting with Version One (1) message formats. In a similar fashion, Table N-3 below defines the 1090 MHz ADS-B message to State Vector Report mapping that **shall** be used when the target aircraft/vehicle is broadcasting using Version Zero (0) messages. Note there are some minor differences in the specific names applied to certain otherwise identical Version Zero (0) versus Version (1) messages subfields. The only new or changed State Vector Report parameter between DO-260 (i.e., Version 0) and these MOPS is for Navigation Intregrity Category (NIC), which has replaced Navigation Uncertainty Category (NUC) from the initial version of this MOPS. The following subparagraph discusses the NIC parameter and its mapping from Version Zero (0) messages to the State Vector Report. The remaining State Vector Report parameters **shall** be generated as described in section 2.2.8.1.

The format of the Version Zero (0) 1090 MHz ADS-B messages are defined in Figures N-1 through N-7.

Table N-3: ADS-B State Vector Data Elements - Version Zero (0) 1090 MHz ADS Messages To Report Structure Mapping

	REPORT STRUCTURE		VERSION ZERO (0) MESSAGE STRUCTURE RELEVANT			REPORT STRUCTURE RELEVANT					
Column #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Item #	**Parameter / Contents**	**Notes**	**Received Message Structure**	**"ME" Field Bits**	**Message Field Bits**	**# of Bits**	**Range**	**Resolution**	**Units**	**Data Structure**	**Data Byte #**
0a, 0b	Report Type and Structure Identification	4	Airborne Position - "DF"	N/A	1 – 5	24	N/A	N/A	discrete	MddL Mddd ddddddddddddddL	0 -2
0c	Validity Flags		N/A	N/A	N/A	16	N/A	N/A	discrete	dddddddd dddddddd	3 - 4
1	Participant Address	4	Airborne Position - "AA" Surface Position - "AA" Airborne Velocity – "AA"	N/A N/A N/A	9 - 32 9 – 32 9 - 32	24	N/A	N/A	discrete	Mddddddd ddddddddDddddddL	5 - 7
2	Address Qualifier		N/A	N/A	N/A	8	N/A	N/A	discrete	00000M0L	8
3	Time of Applicability (Position and Velocity)	4	Airborne Position – "Time" Surface Position – "Time" Airborne Velocity	21 21 N/A	53 53 N/A	24	511.9921875	0.0078125 (1/128)	seconds	Mddddddd ddddddddL Mddddddd ddddddddL Mddddddd ddddddddL	9 - 11
4	Latitude (WGS-84)	4	Airborne Position – "Encoded Latitude" Surface Position – "Encoded Latitude"	23 - 39 23 - 39	55 - 71 55 – 71	24	+/- 180	0.0000215	degrees	SMddddddd ddddddddDddddddL	12 - 14
5	Longitude (WGS-84)	4	Airborne Position – "Encoded Longitude" Surface Position – "Encoded Longitude"	40 - 56 40 - 56	72 - 88 72 – 88	24	+/- 180	0.0000215	degrees	SMddddddd ddddddddDddddddL	15 - 17
6	Altitude, Geometric (WGS-84)	4, 5	Airborne Position – "TYPE", **&** "Altitude" Airborne Velocity – "Diff. Sign Bit" & "Geo Height Diff. from Baro. Alt."	1 - 5, **&** 9 - 20 49 50 - 56	33 - 37 41 – 52 81 82 - 88	24	+/- 131,072	0.015625	feet	SMddddddd ddddddddddddddL	18 - 20
7	North / South Velocity	4, 5	Airborne Velocity – "Direction Bit for N-S Vel." & "N/S Velocity"	25 26 - 35	57 58 – 67	16	+/- 4,096	0.125	knots	SMddddddd ddddddddL	21 - 22
8	East / West Velocity	4, 5	Airborne Velocity – "Direction Bit E-W Vel." & "E/W Velocity"	14 15 - 24	46 47 – 56	16	+/- 4,096	0.125	knots	SMddddddd ddddddddL	23 - 24
9	Ground Speed while on the Surface	4, 6	Surface Position – "Movement"	6 - 12	38 – 44	8	N/A	N/A	discrete	MddddddL	25

	REPORT STRUCTURE		VERSION ZERO (0) MESSAGE STRUCTURE RELEVANT			REPORT STRUCTURE RELEVANT					
Column #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Item #	**Parameter / Contents**	**Notes**	**Received Message Structure**	**"ME" Field Bits**	**Message Field Bits**	**# of Bits**	**Range**	**Resolution**	**Units**	**Data Structure**	**Data Byte #**
10	Heading while on the Surface	4, 6	Surface Position – "Ground Track"	14 - 20	46 – 52	8	+/- 180	1.40625	degrees	SMdddddL	26
11	Altitude, Barometric (Pressure Altitude)	4, 5	Airborne Position – "TYPE", **&** "Altitude"	1 - 5 9 - 20	33 – 37 41 – 52	24	+/- 131,072	0.015625	feet	SMdddddd ddddddddddddddL	27 - 29
12	Vertical Rate, Geometric/Barometric (WGS-84)	4, 5	Airborne Velocity – "Source Bit for Vert. Rate ", "Sign Bit for Vert. Rate " & "Vert. Rate"	36 37 38 - 46	68 69 70 – 78	16	+/- 32,768	1.0	ft./min.	SMdddddd ddddddddL	30 - 31
13	Navigation Integrity Category (NIC)	4	Airborne Position "Type Code" Surface Position "Type Code"	1 – 5 1 - 5	33 – 37 33 - 37	8	N/A	N/A	discrete	0000MddL	32
14	Estimated Latitude (WGS-84)	7	Airborne Position – "Encoded Latitude" Surface Position – "Encoded Latitude"	23 - 39 23 - 39	55 - 71 55 – 71	24	24	+/- 180	0.0000215	degrees	33 - 35
15	Estimated Longitude (WGS-84)	7	Airborne Position – "Encoded Longitude" Surface Position – "Encoded Longitude"	40 - 56 40 - 56	72 - 88 72 – 88	24	24	+/- 180	0.0000215	degrees	36 - 38
16	Estimated North/South Velocity	7	Airborne Velocity – "Direction Bit for N-S Vel." & "N-S Velocity"	25 26 - 35	57 58 – 67	16	+/- 4,096	0.125	knots	SMdddddd ddddddddL	39 - 40
17	Estimated East/West Velocity	7	Airborne Velocity – "Direction Bit for E-W Vel." & "E-W Velocity"	14 15 - 24	46 47 – 56	16	+/- 4,096	0.125	knots	SMdddddd ddddddddL	41 - 42
18	Surveillance Status/Discretes		Airborne Position – "Surveillance. Status" Airborne Velocity – "Intent Change Flag"	6 – 7 9	38 – 39 9	4 4	N/A	N/A	discrete	dddd dddd	43
19	Report Mode		N/A	N/A	N/A	8	N/A	N/A	discrete	000000ML	44
										TOTAL BYTES	45

Notes:

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0) and "x" indicates "Don't Care" bits in the data field.*

2. *If data is not available to support theses fields, then the entire data field shall be set to ALL ZEROs if the field is delivered to the application.*
3. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as defined in section 2.2.8.1.1.1.*
4. *Items annotated with Note 4 represent "Critical" State Vector items, however certain items are only applicable while airborne and others only applicable while on the surface (see Notes 5 and 6 below).*
5. *Parameters annotated with Note 5 are only present in the State Vector Report when the aircraft is airborne*
6. *Parameters annotated with Note 6 are only present in the State Vector Report with the aircraft is on the airport surface*
7. *Estimated values may be either an actual value from a received message, if available, or a calculated value such as produced by a surveillance tracker algorithm. For example it is possible for a surveillance tracker to produce an updated estimate of the target's horizontal position based on just the receipt of a new velocity message.*
8. *The Time of Applicability is actually a grouping of 3 individual parameters as defined in 2.2.8.1.4*

N.3.1.1 Navigation Integrity Category (NIC)

The ADS-B Version Zero (0) surface and airborne position messages have associated with each specific Type Code a corresponding Horizontal Protection Limit and a 95% Containment Radius. For the purpose of generating a State Vector Report, DO-260 (i.e., Version 0) mapped these message parameters to a Navigation Uncertainty Category (NUC). As defined by Table 2-11, Version One (1) surface and airborne position messages associated the message Type Code with the parameters of Horizontal Containment Limit (R_C) and Navigation Integrity Category (NIC). Although Version Zero (0) messages were not defined by DO-260 to directly include a value for NIC, the values defined by Table 2-11 for R_C and NIC have been selected such that the it is possible to map the Type Code values from Version Zero (0) message to a corresponding value for NIC. The Surface and Airborne Position message Type Codes associated with Version Zero (0) 1090 MHz ADS-B messages **shall** be mapped to the NIC values shown in Table N-4 for the purpose of generating State Vector Reports.

Table N-4: Version Zero (0) Format Type Code Mapping to Navigation Source Characteristics

"TYPE" Subfield Code Definitions (DF = 17 or 18)					
Type Code	**Format**	**Horizontal Protection Limit, HPL**	**95% Containment Radius, m and n, On Horizontal and Vertical Position Error**	**Altitude Type**	**Reported NIC**
0	No Position Information			Baro Altitude or No Altitude Information	0
5	Surface Position	HPL < 7.5 m	μ< 3 m	No Altitude Information	11
6	Surface Position	HPL < 25 m	3 m $\leq \mu$ < 10 m	No Altitude Information	10
7	Surface Position	HPL < 185.2 m (0.1 NM)	10 m $\leq \mu$ < 92.6 m (0.05 NM)	No Altitude Information	8
8	Surface Position	HPL $\geq$ 185.2 m (0.1 NM)	(0.05 NM) 92.6 m $\leq \mu$	No Altitude Information	0
9	Airborne Position	HPL < 7.5 m	μ < 3 m	Baro Altitude	11
10	Airborne Position	7.5 m $\leq$ HPL < 25 m	3 m $\leq \mu$ < 10 m	Baro Altitude	10
11	Airborne Position	25 m $\leq$ HPL < 185.2 m (0.1 NM)	10 m $\leq \mu$ < 92.6 m (0.05 NM)	Baro Altitude	8
12	Airborne Position	185.2 m (0.1 NM) $\leq$ HPL < 370.4 m (0.2 NM)	92.6 m (0.05 NM) $\leq \mu$ < 185.2 m (0.1 NM)	Baro Altitude	7
13	Airborne Position	380.4 m (0.2 NM) $\leq$ HPL < 926 m (0.5 NM)	185.2 m (0.1 NM) $\leq \mu$ < 463 m (0.25 NM)	Baro Altitude	6
14	Airborne Position	26 m (0.5 NM) $\leq$ HPL < 1852 m (1.0 NM)	463 m (0.25 NM) $\leq \mu$ < 926 m (0.5 NM)	Baro Altitude	5
15	Airborne Position	1852 m (1.0 NM) $\leq$ HPL < 3704 m (2.0 NM)	926 m (0.5 NM) $\leq \mu$ < 1.852 km (1.0 NM)	Baro Altitude	4
16	Airborne Position	7.704 km (2.0 NM) $\leq$ HPL < 18.52 km (10 NM)	1.852 km (1.0 NM) $\leq \mu$ < 9.26 km (5.0 NM)	Baro Altitude	1
17	Airborne Position	18.52 km (10 NM) $\leq$ HPL < 37.04 km (20 NM)	9.26 km (5.0 NM) $\leq \mu$ < 18.52 km (10.0 NM)	Baro Altitude	1
18	Airborne Position	HPL $\geq$ 37.04 km (20 NM)	8.52 km (10.0 NM) $\leq \mu$	Baro Altitude	0
20	Airborne Position	HPL < 7.5 m	μ < 3 m and ν < 4 m	GNSS Height (HAE)	11
21	Airborne Position	HPL < 25 m	μ < 10 m and ν < 15 m	GNSS Height (HAE)	10
22	Airborne Position	HPL $\geq$ 25 m	$\mu \geq$ 10 m or $\nu \geq$ 15 m	GNSS Height (HAE)	0

Notes:

1. *"Baro-Altitude" refers to barometric pressure altitude, relative to a standard pressure of 1013.25 millibars (29.92 in Hg). It does not refer to baro corrected altitude.*
2. *The GNSS height (HAE) defined in Type Codes 20 to 22 is used when baro altitude is not available.*
3. *ADS-B Version Zero (0) message formats define the 95% containment limit, m, on horizontal position error is derived from ARINC 429 label 247, HFOM (Horizontal Figure of Merit). Likewise, the 95% containment limit, n, on vertical position error is derived from ARINC 429 label 136, VFOM (Vertical Figure of Merit). The horizontal protection level, HPL, is derived from ARINC 429 label 130, which is variously called HIL (Horizontal Integrity Limit) or HPL (Horizontal Protection Level).*

N.4 Mode Status Reports

Table 2.2.8.2 defines the overall Mode Status Report format and the source for each parameter that is to be reported when the target aircraft/vehicle is broadcasting with Version One (1) message formats. In a similar fashion, Table N-5 below defines the 1090 MHz ADS-B message-to-State Vector Report mapping that **shall** be used when the target aircraft/vehicle is broadcasting using Version Zero (0) messages. Note there are some significant differences in the message parameters available from Version Zero (0) versus Version (1) messages. This results in Mode Status reports related to target aircraft/vehicles broadcasting Version Zero (0) messages being substantially less complete than would be possible when Version One (1) messages are being received. The following subparagraphs discuss the those Mode Status Report parameters the must be processed and/or mapped differently for Version Zero (0) messages. The remaining Mode Status Report parameters not specifically addressed in the following subparagraphs **shall** be generated as described in section 2.2.8.1 (i.e., using the same mapping as for Version One (1) messages).

The format of the Version Zero (0) 1090 MHz ADS-B messages are defined in Figures N-1 through N-7.

Table N-5: ADS-B Mode Status Data Elements - Version Zero (0) 1090 MHz ADS Messages To Report Structure Mapping

	REPORT STRUCTURE		MESSAGE STRUCTURE RELEVANT			REPORT STRUCTURE RELEVANT					
Column #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Item #	**Parameter / Contents**	**Notes**	**Received Version 0 Message Sources**	**"ME" Field Bits**	**Message Field Bits**	**# of Bits**	**Range**	**Resolution**	**Units**	**Data Structure**	**Data Byte #**
0a,0b	Report Type and Structure		N/A	N/A	N/A	24	N/A	N/A	discrete	MddL Mddd ddddddddd ddddddddL	0 - 2
0c	Validity Flags		N/A	N/A	N/A	8	N/A	N/A	discrete	ddddddddd	3
1	Participant Address		Airborne Velocity - "AA" - OR - Operational Status – "AA" - OR - Aircraft Identification – "AA"	N/A N/A N/A	9 – 32 9 – 32 9 – 32	24 24 24	N/A	N/A	discrete	Mddddddd ddddddddd ddddddddL	4 – 6
2	Address Qualifier		N/A reserved for future use			8	N/A	N/A	discrete	00000M0L	7
3	Time of Applicability		N/A	N/A	N/A	16	511.9921875	0.0078125 (1/128)	seconds	Mddddddd ddddddddL	8 - 9
4	ADS-B Version		Operational Status – "Version Number"	41 - 43	73 - 75	8	0 - 7	1	discrete	00000MdL	10
5a	Call Sign		Aircraft Identification – "Ident Char."	14 – 56	41 – 88	64	N/A	N/A	Alphanumeric characters	0MddddddL 0MddddddL 0MddddddL 0MddddddL 0MddddddL 0MddddddL 0MddddddL 0MddddddL	11 – 18
5b	Emitter Category		Aircraft Identification – "Emitter Category"	6 – 8	38 - 40	8	N/A	N/A	discrete	000MdddL	19
5c	A/V Length and Width Codes	5	N/A	21 - 24	53 - 56	8	N/A	N/A	N/A	00000000	20
6	Emergency/Priority Status		Aircraft Status Message – Subtype 1 – "Emergency/Priority Status"	9 - 11	36 - 38	8	N/A	N/A	discrete	00000MbL	21
7	Capability Codes		Operational Status – "CC-4"	9 - 12	41 - 44	24	See Section N.4.4			00000000 dd000000 00000000	22 - 24
8	Operational Mode	4	N/A			16	N/A	N/A	N/A	00000000 00000000	25 - 26

9a	SV Quality - NACp		Airborne Position "Type Code" Surface Position "Type Code"	1 – 5 1 - 5	33 – 37 33 - 37	8	N/A	N/A	discrete	00000000	27
9b	SV Quality - NACv		Airborne Velocity Message – "NUC_R"	11 - 13	43-45	8	N/A	N/A	discrete	00000MdL	28
9c	SV Quality – SIL	4, 5	Airborne Position – "Type Code" Surface Position – "Type Code"	1 – 5 1 - 5	33 – 37 33 - 37	8	N/A	N/A	discrete	000000ML	29
9d	SV Quality – BAQ (reserved)		N/A	N/A	N/A	8	N/A	N/A	discrete	000000ML	30
9e	SV Quality – NICbaro	4	N/A	N/A	N/A	8	N/A	N/A	discrete	0000000L	31
10a	Track/Heading and Horizontal Reference Direction (HRD)	4	Airborne Velocity – "SUBTYPE" - "Magnetic Heading Status Bit" Surface Position Message – "Status Bit for Ground Track"	6 - 8 14 13	38 - 40 46 45	8	N/A	N/A	discrete	0000000L	32
10b	Vertical Rate Type		Airborne Velocity – "Vert. Rate Source"	36	68	8	N/A	N/A	discrete	0000000L	33
11	Other (Reserved)		Reserved			8	Reserved			ddddddd	34
										TOTAL BYTES:	35

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0), and "x" indicates "Don't Care" bits in the data field.*

2. *If data is not available to support these fields, then the entire data field shall be set to ALL ZEROs.*

3. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as defined in section 2.2.8.1.1.1.*

4. *This parameter is not available for aircraft/vehicles broadcasting Version Zero (0) ADS-B messages. If included in the Mode Status report the value of this parameter is to be set to all zeros otherwise it may be omitted from the Mode Status Report and its omission indicated in the Report Type and Structure Parameter using the format defined in Table 2.2.8.2.1.1.*

5. *This parameter is not available for aircraft/vehicles broadcasting Version Zero (0) ADS-B messages. This parameter is to be omitted from the Mode Status Report and its omission indicated in the Report Type and Structure Parameter using the format defined in Table 2.2.8.2.1.1.*

N.4.1 ADS-B Version

The format of the Operational Status message substantially differs between the ADS-B Version Zero (0) format shown in Figure N-7 and the ADS-B Version One (1) format defined by paragraph 2.2.3.2.7.3 of this MOPS. The Version One (1) Operational Status message format includes an explicit Version Number subfield (ME bits 41-43). For an ADS-B Version Zero (0) Operational Status message these same bits are unassigned and are expected to be set to a value of zero. An ADS-B Version One (1) receiving system shall, as a default, assume the received messages are using ADS-B Version Zero (0) format unless or until an Operational Status Message is received and the version number is confirmed to be other than Zero. However, in the case of an ADS-B Version One (1) system's reception of an Operational Status message, the receiving system **shall** decode "ME" bits 41-43 and determine if the target aircraft is broadcasting messages that are ADS-B Version Zero (0) or Version One (1) and then decode the remainder of the message in accordance with the message format applicable to that version number.

Notes:. *The version number determined from the decoding of the Version Number subfield of the Operational Status message must be retained and associated with the specific target since it is used in determining the applicable formats to be used for the decoding of the other message types.*

N.4.2 Emitter Category

The ADS-B Report Assembly Function **shall** extract "TYPE" and "ADS-B Emitter Category" from the Aircraft Identification and Type Message (Figure N-3) and encode the "Emitter Category" field of the Mode Status Report as shown in Table 2.2.8.2.7. The Emitter Category conveyed in the Aircraft Identification and Type Message shall be mapped into the Mode Status Report, Emitter Category field as defined by Table 2.2.8.2.7. However, it must be noted that in the Version Zero (0) Aircraft Identification and Type Message, the Emitter Category subfield conveys a subset of the emitter categories allowed by the Mode Status Report.

N.4.3 A/V Length and Width Codes

The A/V Length and Width Codes are not conveyed by Version Zero (0) 1090 MHz ADS-B messages. This parameter is only included in the Mode Status Report when reporting on an aircraft or vehicle that is on the airport surface. When no A/V Length and Wide Code is available, as is the case for target A/V that are broadcasting Version Zero (0) messages, the A/V Length and Wide Code parameter **shall** not be included in the Mode Status Report and its omission so indicated in the Report Type and Structure Parameter using the coding defined in Table 2.2.8.2.1.1.

N.4.4 Emergency/Priority Status

The Emergency/Priority Status conveyed in the Aircraft Status Message (Figure N-6 **shall** be directly mapped into the Mode Status Report, Emergency/Priority Status field as defined by section 2.2.8.2.9. However, it must be noted that in the Version Zero (0) Aircraft Status Message, the Emergency/Priority Status subfield conveys a subset of the Emergency/Priority Status categories allowed by the Mode Status Report.

N.4.5 Capability Codes

The Version Zero (0) Operational Status Message (Figure N-7) conveys Control Codes with information limited to TCAS and CDTI capabilities, as shown in Table N-6. The Version Zero (0) Operation Status message format defines coding only for the case of CC-4 (En Route Operational Capabilities). Therefore the CC-1, CC-2 and CC-3 subfields, as defined in Figure N-7, are to be considered reserved and not used for ADS-B Version Zero (0) messages.

For the case of CC-4, this 4-bit (9-12) subfield **shall** be mapped to the Capability Code field of the Mode Status Report as shown in Table N-6. The remaining bits within the Mode Status Report Capability Code field **shall** be set to Zero (0). If no Operational Status message has been received, then the Capability Code field may be omitted from the Mode Status Report and its omission so indicated in the Report Type and Structure Parameter using the coding defined in Table 2.2.8.2.1.1.

Table N-6: En Route Operational Capabilities Encoding

CC-4 ENCODING: EN ROUTE OPERATIONAL CAPABILITIES			
CC-4 CODING (Version Zero (0) Messages)		**Meaning** (Version Zero (0) Messages)	**Mapping to MS Report** Capability Code field
Bit 9,10	Bit 11,12		CC Field Bits 11, 12
0 0	**0 0**	*TCAS Operational or unknown; CDTI not Operational or unknown*	10
	0 1	*TCAS Operational or unknown; CDTI Operational*	11
	1 0	*TCAS not Operational; CDTI not Operational or unknown*	00
	1 1	*TCAS not Operational; CDTI Operational*	01

N.4.6 Operational Mode

ADS-B Version Zero (0), DO-260 conformant, message formats do not define coding for the Operational Mode subfield of the operational status message. Therefore the OM-1, OM-2, OM-3 and OM-4 subfields, as shown in Figure N-7, are to be considered reserved and not used for ADS-B Version Zero (0) messages. Mode Status Reports for target aircraft/vehicles broadcasting Version Zero (0) message **shall** not include the Operational Mode field in the report and indicate the omission of this parameter in the Report Type and Structure Parameter using the coding defined in Table 2.2.8.2.1.1.

N.4.7 NAC_P

The ADS-B Version Zero (0) surface and airborne position messages have associated with each specific TYPE code a corresponding Horizontal Protection Limit and a 95% Containment Radius (i.e., position error). For a Version One (1) receiving system the TYPE codes of the received Version Zero (0) messages **shall** be mapped into the value of NAC_P as shown below in Table N-7 for the purpose of generating the Mode Status Report.

Table N-7: Type Code to NAC_P Mapping

Version 0 Message TYPE CODE	Message Format	Position Error (95%)	ADS-B MS Report NAC_P value
0	No Position Info	Unknown	0
5	Surface Position	< 3 m	11
6	Surface Position	< 10 m	10
7	Surface Position	< 0.05 NM	8
8	Surface Position	> 0.05 NM	0
9	Airborne Position	< 3 m	11
10	Airborne Position	< 10 m	10
11	Airborne Position	< 0.05 NM	8
12	Airborne Position	< 0.1 NM	7
13	Airborne Position	< 0.25 NM	6
14	Airborne Position	< 0.5 NM	5
15	Airborne Position	< 1 NM	4
16	Airborne Position	< 5 NM	1
17	Airborne Position	< 10 NM	1
18	Airborne Position	> 10 NM	0
20	Airborne Position	< 4 m	11
21	Airborne Position	< 15 m	10
22	Airborne Position	> 15 m	0

Note: *The Position Error column of the table indicates the greater of the horizontal or vertical 95% containment radius as listed in Table N-4 for Version Zero (0) messages.*

N.4.8 NAC_V

The Version Zero (0) Airborne Velocity Message (Figures N-4 and N-5) includes a subfield that conveys the Navigation Uncertainty Category for Velocity (NUC_R). The received value of NUC_R **shall** be mapped directly one-for-one to the NAC_V field of Mode Status Report.

N.4.9 SIL

The surveillance integrity level (SIL) defines the probability of the integrity containment radius being exceeded (i.e., the probability of being outside the NIC radius without detection). The value of SIL can only be inferred from the information conveyed in Version Zero (0) ADS-B messages. Table N-8 provides the mapping between the message Type Code for a Version Zero (0) transmitting system and the value of SIL to be reported by a Version One (1) receiving system within the Mode Status Report (see §2.2.8.2.14).

Table N-8: SIL Reporting

Version 0 Message TYPE CODE	**Message Format**	**Integrity Level** (probability of exceeding the reported containment radius without detection)	**ADS-B MS Report SIL value**
0	No Position Info	No Integrity	0
5	Surface Position	1×10^{-5} per flight hour	2
6	Surface Position	1×10^{-5} per flight hour	2
7	Surface Position	1×10^{-5} per flight hour	2
8	Surface Position	1×10^{-5} per flight hour	2
9	Airborne Position	1×10^{-5} per flight hour	2
10	Airborne Position	1×10^{-5} per flight hour	2
11	Airborne Position	1×10^{-5} per flight hour	2
12	Airborne Position	1×10^{-5} per flight hour	2
13	Airborne Position	1×10^{-5} per flight hour	2
14	Airborne Position	1×10^{-5} per flight hour	2
15	Airborne Position	1×10^{-5} per flight hour	2
16	Airborne Position	1×10^{-5} per flight hour	2
17	Airborne Position	1×10^{-5} per flight hour	2
18	Airborne Position	No Integrity	0
20	Airborne Position	1×10^{-5} per flight hour	2
21	Airborne Position	1×10^{-5} per flight hour	2
22	Airborne Position	No Integrity	0

N.4.10 NIC_{baro}

The NIC_{baro} parameter of the Mode Status Report is a 1-bit flag used to indicate if the barometric altitude being reported in the State Vector Report has been cross-checked against another source of pressure altitude. The Version Zero (0) messages do not include information related to the cross-checking of barometric altitude. Therefore, Mode Status Reports for target aircraft/vehicles broadcasting Version Zero (0) message **shall** not include the NIC_{baro} field in the report and the indicate the omission of this parameter in the Report Type and Structure Parameter using the coding defined in Table 2.2.8.2.1.1.

N.4.11 Track/Heading and Horizontal Reference Direction (HRD)

Version Zero (0) Airborne Velocity messages with SUBTYPE equal to 3 or 4 include in "Magnetic Heading Status Bit" as shown in Figure N-4. An 1090 MHz ADS-B receiving system, upon receiving an airborne velocity message with a Subtype of 3 or 4, must decode the Magnetic Heading Status Bit to determine if Magnetic Heading Data is Available. The receiving system **shall** set the value of the True/Magnetic Heading subfield, as defined in paragraph 2.2.8.2.17, of the Mode Status Report as defined below by Table N-9.

Table N-9: Track/Heading and HRD Subfield

Version 0 Airborne Velocity Message SUBTYPE	Airborne Velocity Message "Magnetic Heading Status Bit"	Surface Position Message "Ground Track Status Bit"	Meaning	ADS-B MS Report True/Magnetic Heading subfield coding Bits 6 - 7
N/A	N/A	0	No Valid Track/ Heading or Heading Direction Reference information available	00
1 or 2	N/A	1	Ground Track being reported	01
3 or 4	0	N/A	Heading relative to true north being reported	00
3 or 4	1	N/A	Heading relative to magnetic north being reported	11

Notes:

1. *When no valid data is available the "Track/Heading and HRD" parameter may be reported as all zeros or omitted from the Mode Status Report and the omission of this parameter indicated in the Report Type and Structure Parameter using the coding defined in Table 2.2.8.2.1.1.*

2. *As defined in 2.2.8.2.17, when receiving Version One (1) messages, the Track/Heading and HRD information are conveyed within the Operation Status Message. However, when receiving Version Zero (0) messages the equivalent information can be determined for airborne aircraft from the value of the "SUBTYPE" subfield and for Subtype=3 or 4 messages the value of the "Magnetic Heading Status Bit" of the Airborne Velocity Message (Figures N-4 and N-5). When a target aircraft/vehicle is on the surface a value of 01 should be reported when a Surface Position Message (Figure N-2) is received with the "Ground Track Status Bit" set to a value of One (1) indicating that the valid ground track data is provided.*

3. *Version 0 Airborne Velocity Messages, Subtypes 3 and 4 always report Heading relative to Magnetic North, never relative to True North.*

N.5 Air Reference Velocity Reports

The requirements of §2.2.8.3.2 for Air Referenced Velocity (ARV) Reports **shall** apply to the ARV report assembly requirements when the target aircraft is broadcasting either Version Zero (0) or Version One (1) message formats.

N.6 Target Status Reports

RTCA DO-260 defined a message format using message Type Code 29 to convey aircraft trajectory intent information in the form of a Trajectory Change Point (TCP) information. A 1090 MHz ADS-B receiving system conforming to this MOPS (i.e., RTCA DO-242A) **shall** not use any message with a type code of 29 that is received from an ADS-B Version Zero (0) aircraft for the purpose of report generation.

Note: Prior to generation of a Target Status Report, the 1090 MHz ADS-B receiving system must positively confirm that any received message with a type code of 29 has originated from a target aircraft with an ADS-B Version Number other than Zero (0). The ADS-B Version can be determined from the contents of the Version Number subfield of the Operational Status message (see 2.2.8.2.5 and N.4.1).

N.7 Formats for Version Zero (0) 1090 MHz ADS-B Messages

1090 MHz ADS-B receivers conformant to these MOPS (RTCA DO-260A) are required receive and decode all Version One (1) compliant messages plus, for backward compatibility, must receive and decode certain messages types conforming to the previous RTCA DO-260, ADS-B Version Zero (0), formats. The following figures define the format of ADS-B Version Zero (0) extended squitter messages that **shall** be received and decoded and used for the generation of ADS-B reports as defined in N.3 through N.6.

Notes: 1. In some cases, ARINC 429 labels are referenced for specific message fields. These references are only intended to clarify the field content, and are not intended as a requirement to use these ARINC 429 labels as the source for the message field.

2. *The formats of the Version Zero (0) messages that are not required to be received and used for report generation by a Version One (1) 1090 MHz ADS-B receiving system are not shown in the following figures.*

Figure N-1 Extended Squitter Airborne Position Message

1	
2	
3	FORMAT TYPE CODE
4	(See N.2.1)
5	
6	SURVEILLANCE STATUS
7	
8	SINGLE ANTENNA FLAG (SAF)
9	
10	
11	ALTITUDE
12	Specified by the Format Type Code
13	
14	(1) the altitude code (AC) as specified
15	in section 2.2.13.1.2 of DO-181B but
16	with the M-bit removed
17	(Ref ARINC 429 Label 203), or
18	
19	(2) GNSS height (HAE)
20	(Ref. ARINC 429 Label 370)
21	TIME (T)
22	CPR FORMAT
23	MSB
24	
25	
26	
27	
28	
29	
30	ENCODED LATITUDE
31	
32	(CPR Airborne Format)
33	
34	
35	
36	
37	
38	
39	LSB
40	MSB
41	
42	
43	
44	
45	
46	
47	ENCODED LONGITUDE
48	
49	(CPR Airborne Format)
50	
51	
52	
53	
54	
55	
56	LSB

Purpose: To provide accurate airborne position information

Surveillance Status coding
0 = no condition information
1 = permanent alert (emergency condition)
2 = temporary alert (change in Mode A identity code other than emergency condition)
3 = SPI condition

Codes 1 and 2 take precedence over code 3.

Note: When horizontal position information is unavailable, but altitude information is available, the airborne position message is transmitted with a Format Type Code of ZERO in bits 1-5 and the barometric pressure altitude in bits 9 to 20. If neither horizontal position nor barometric altitude information is available, then all 56 bits of register 0,5 shall be ZEROed. The ZERO Format Type Code field indicates that latitude and longitude information is unavailable, while the ZERO altitude field indicates that altitude information is unavailable.

Figure N-2 Extended Squitter Surface Position Message

1	
2	
3	FORMAT TYPE CODE
4	(See N.2.1)
5	
6	
7	
8	
9	MOVEMENT
10	
11	
12	
13	STATUS for Gnd Tk (1 =valid, 0 = not valid)
14	MSB
15	
16	GROUND TRACK (7 bits)
17	
18	
19	**Resolution = 360/128 deg**
20	LSB
21	TIME (T
22	CPR FORMAT (F)
23	MSB
24	
25	
26	
27	
28	
29	
30	ENCODED LATITUDE
31	
32	(CPR Surface Format)
33	
34	
35	
36	
37	
38	
39	LSB
40	MSB
41	
42	
43	
44	
45	
46	
47	ENCODED LONGITUDE
48	
49	(CPR Surface Format)
50	
51	
52	
53	
54	
55	
56	LSB

Purpose: To provide accurate surface position information.

Figure N-3 Extended Squitter Aircraft Identification and Type Message

1		
2		
3	FORMAT TYPE CODE (See N.2.1)	
4		
5		
6		
7	AIRCRAFT CATEGORY	
8		
9	MSB	
10		
11	CHARACTER 1	
12		
13		
14	LSB	
15	MSB	
16		
17	CHARACTER 2	
18		
19		
20	LSB	
21	MSB	
22		
23	CHARACTER 3	
24		
25		
26	LSB	
27	MSB	
28		
29	CHARACTER 4	
30		
31		
32	LSB	
33	MSB	
34		
35	CHARACTER 5	
36		
37		
38	LSB	
39	MSB	
40		
41	CHARACTER 6	
42		
43		
44	LSB	
45	MSB	
46		
47	CHARACTER 7	
48		
49		
50	LSB	
51	MSB	
52		
53	CHARACTER 8	
54		
55		
56	LSB	

Purpose: To provide aircraft identification and type.

Type coding:

1 = Aircraft identification, category set D
2 = Aircraft identification, category set C
3 = Aircraft identification, category set B
4 = Aircraft identification, category set A

ADS-B Emitter Category coding:

Set A
0 = No ADS-B Emitter Category Information
1 = Light (< *15 500* lbs.)
2 = Small (*15 500* to 75 000 lbs.)
3 = Large (75 000 to 300 000 lbs.)
4 = High Vortex Large(aircraft such as B-757)
5 = Heavy (> 300 000 lbs.)
6 = High Performance (> 5 g acceleration and > 400kts)
7 = Rotorcraft

Set B
0 = No ADS-B Emitter Category Information
1 = Glider/sailplane
2 = Lighter-than-Air
3 = Parachutist/Skydiver
4 = Ultralight/hang-glider/paraglider
5 = Reserved
6 = Unmanned Aerial Vehicle
7 = Space/Trans-atmospheric vehicle

Set C
0 = No ADS-B Emitter Category Information
1 = Surface Vehicle – Emergency Vehicle
2 = Surface Vehicle – Service Vehicle
3 = Fixed Ground or Tethered Obstruction
4-7 = Reserved

Set D : Reserved

Aircraft identification coding:

Coding as specified for N.4.4

Figure N-4 Extended Squitter Airborne Velocity Message (Subtypes 1 and 2: Velocity Over Ground)

1	MSB		**1**	
2			**0**	
3	FORMAT TYPE CODE = 19		**0**	
4	(See N.2.1)		**1**	
5	LSB		**1**	
6	SUBTYPE 1	0	SUBTYPE 2	0
7		0		1
8		1		0
9	INTENT CHANGE FLAG)			
10	IFR CAPABILITY FLAG			
11	NAVIGATION UNCERTAINTY			
12	CATEGORY – VELOCITY			
13	(NUC_R)			
14	DIRECTION BIT for E-W velocity **(0=East, 1=West)**			
15	EAST-WEST VELOCITY (10 bits)			
16	NORMAL : LSB = 1 knot		SUPERSONIC : LSB =4 knots	
17	All zeros = no velocity info		All zeros = no velocity info	
18	Value	Velocity	Value	Velocity
19	1	0 kts	1	0 kt
20	2	1 kt	2	4 kt
21	3	2 kt	3	8 kt
22	-	-	-	-
23	1022	1021 kt	1022	4084 kt
24	1023	>1021.5 kt	1023	> 4086kt
25	DIRECTION BIT for N-S velocity **(0=North, 1=South)**			
26	NORTH-SOUTH VELOCITY (10 bits)			
27	NORMAL : LSB = 1 knot		SUPERSONIC : LSB =4 knots	
28	All zeros = no velocity info		All zeros = no velocity info	
29	Value	Velocity	Value	Velocity
30	1	0 kts	1	0 kt
31	2	1 kt	2	4 kt
32	3	2 kt	3	8 kt
33	-	-	-	-
34	1022	1021 kt	1022	4084 kt
35	1023	>1021.5 kt	1023	> 4086kt
36	SOURCE BIT FOR VERTICAL RATE: 0 = Geometric, 1 = baro (1 bit)			
37	SIGN BIT FOR VERTICAL RATE: 0 = up, 1 = down			
38	VERTICAL RATE (9 bits)			
39	All zeros – no vertical rate information, LSB = 64 ft/min			
40	Value	Vertical rate	Ref. ARINC 429 labels	
41	1	0 ft/min	GPS: 165	
42	2	64 ft/min	INS: 365	
43	-	-		
44	510	32576 ft/min		
45	511	> 32608 ft/min		
46				
47	TURN INDICATOR (2 bits)			
48	TBD			
49	DIFFERENCE SIGN BIT (0 = above baro, 1 = below baro alt))			
50	GEOMETRIC HEIGHT DIFFERENCE FROM BARO. ALT. (7 bits)			
51	All zeros = no info; LSB = 25 ft			
52	Value	Difference		
53	1	0 ft		
54	2	25 ft		
55	-	-		
56	126	3125 ft		
	127	> 3137.5 ft		

Purpose: To provide additional state information for both normal and supersonic flight.

Subtype Coding

Code	Velocity	Type
	As in first edition of the ICAO Manual on Mode S Specific Services	
1	Ground speed	normal
2		supersonic
3	Airspeed, heading	normal
4		supersonic
5	Not assigned	
6	Not assigned	
7	Not assigned	

IFR Capability Flag coding:

0 = Transmitting aircraft has no capability for applications requiring ADS-B equipage class A1 or above

1 = Transmitting aircraft has capability for applications requiring ADS-B equipage class A1 or above.

Ref. ARINC Labels for Velocity:

East-West	North-South
GPS: 174	GPS: 166
INS: 367	INS: 366

Ref. ARINC Labels
GNSS Height (HAE): GPS: 370
GNSS Altitude (MSL): GPS: 076

Navigation Uncertainty Category:

$HFOM_R$ value		**$VFOM_R$ value**	**NUC_R value**
$HFOM_R$ < 0.3 m/s (0.984 fps)	AND	$VFOM_R$ < 0.46 m/s (1.5 fps)	4
$HFOM_R$ < 1 m/s (3.28 fps)	AND	$VFOM_R$ < 1.5 m/s (5.0 fps)	3
$HFOM_R$ < 3 m/s (9.84 fps)	AND	$VFOM_R$ < 4.6 m/s (15.0 fps)	2
$HFOM_R$ < 10 m/s (32.8 fps)	AND	$VFOM_R$ < 15.2 m/s (50 fps)	1
$HFOM_R$ unknown or $HFOM_R$ ≥10 m/s (32.8 fps)	OR	$VFOM_R$ unknown or $VFOM_R$ ≥ 15.2 m/s (50 fps)	0

Figure N-5 Extended Squitter Airborne Velocity Message
(Subtypes 3 and 4: Airspeed and Heading)

1	MSB			**1**	
2				**0**	
3	FORMAT TYPE CODE = 19			**0**	
4	(See N.2.1)			**1**	
5	LSB			**1**	
6	SUBTYPE 3	0	SUBTYPE 4	1	
7		1		0	
8		1		0	
9	INTENT CHANGE FLAG				
10	IFR CAPABILITY FLAG				
11	NAVIGATION UNCERTAINTY				
12	CATEGORY – VELOCITY				
13	(NUC_R)				
14	STATUS BIT – 1 = Magnetic heading available, 0 = not available				
15	MSB				
16					
17					
18	MAGNETIC HEADING (10 bits)				
19	(N.4.5.5)				
20					
21				Ref. ARINC 429 Label:	
22				INS: 320	
23	Resolution = 360/1024 deg				
24	LSB				
25	AIRSPEED TYPE: 0 = IAS, 1 = TAS				
26	AIRSPEED (10 bits)				
27	NORMAL : LSB = 1 knot		SUPERSONIC : LSB =4 knots		
28	All zeros = no velocity info		All zeros = no velocity info		
29	Value	Velocity	Value	Velocity	
30	1	0 kts	1	0 kt	
31	2	1 kt	2	4 kt	
32	3	2 kt	3	8 kt	
33	-	-	-	-	
34	1022	1021 kt	1022	4084 kt	
35	1023	>1021.5 kt	1023	> 4086 kt	
36	SOURCE BIT FOR VERTICAL RATE: 0 = Geometric, 1 = baro (1 bit)				
37	SIGN BIT FOR VERTICAL RATE: 0 = up, 1 = down				
38	VERTICAL RATE (9 bits)				
39	All zeros – no vertical rate information				
40	LSB = 64 ft/min				
41	Value	Vertical rate		Ref. ARINC labels	
42	1	0 ft/min		GPS: 165	
43	2	64 ft/min		INS: 365	
44	-	-			
45	510	32576 ft/min			
46	511	> 32608 ft/min			
47	TURN INDICATOR (2 bits)				
48	TBD				
49	DIFFERENCE SIGN BIT (0 = above baro, 1 = below baro alt))				
50	GEOMETRIC HEIGHT DIFFERENCE FROM BARO. ALT. (7 bits)				
51	All zeros = no info; LSB = 25 ft				
52	Value	Vertical rate		Ref. ARINC 429 labels	
53	1	0 ft			
54	2	25 ft			
55	-	-			
56	126	3125 ft			
	127	> 3137.5 ft			

Purpose: To provide additional state information for both normal and supersonic flight based on airspeed and heading.

Note: *This format is only used if velocity over ground is not available*

See the definition of NUC_R in section 2.2.3.2.6.1.5.

Subtype Coding

Code	Velocity	Type
0	As in first edition of the ICAO Manual on Mode S Specific Services	
1	Ground speed	normal
2		supersonic
3	Airspeed, heading	normal
4		supersonic
5	Not assigned	
6	Not assigned	
7	Not assigned	

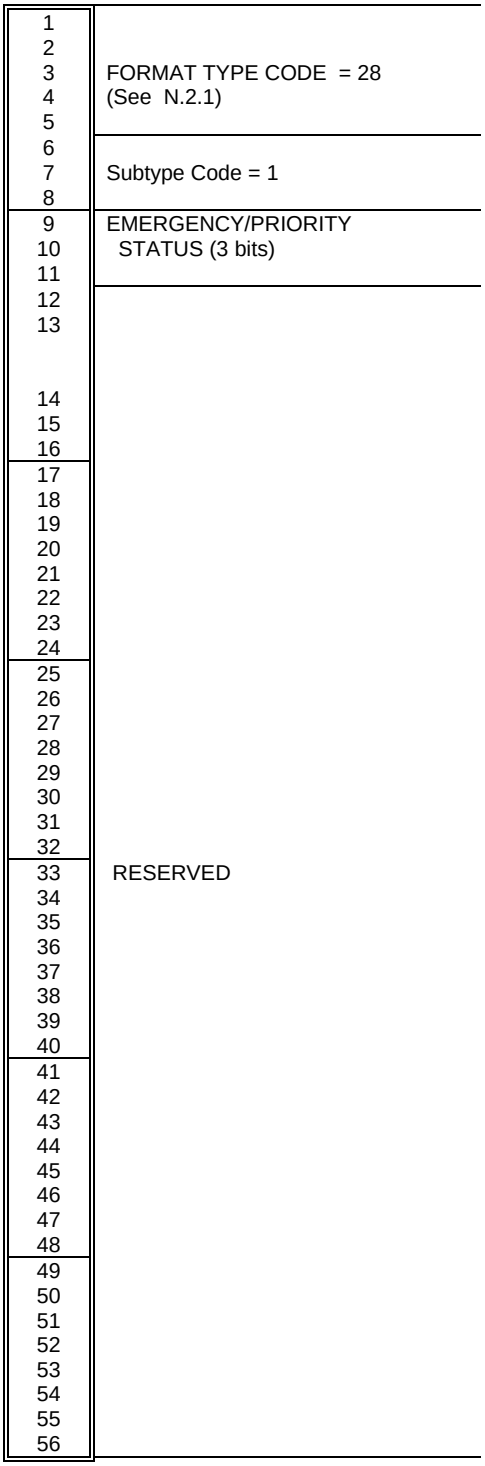
IFR Capability Flag coding:

0 = Transmitting aircraft has no capability for applications requiring ADS-B equipage class A1 or above

1 = Transmitting aircraft has capability for applications requiring ADS-B equipage class A1 or above.

Ref. ARINC 429 Labels for Air Data Source:
IAS: 206
TAS: 210

Figure N-6 Extended Squitter Aircraft Status Message
(Subtype 1: Emergency/Priority Status)



Purpose. To provide additional information on aircraft status.

Subtype Coding:

0 = No Information
1 = Emergency/Priority Status
2-7 = Reserved

Emergency/Priority Status Coding

Value	*Meaning*
0	No emergency
1	General emergency
2	Lifeguard/medical
3	Minimum fuel
4	No communications
5	Unlawful interference
6	Reserved
7	Reserved

Notes:

1. *Message delivery is accomplished once per second using the event driven protocol.*

2. *Termination of emergency state is detected by coding in the surveillance status field of the airborne position message.*

Figure N-7 Aircraft Operational Status Message

1	MSB
2	
3	FORMAT TYPE CODE = 31
4	(See N.2.1)
5	LSB
6	MSB
7	Subtype Code=0
8	LSB
9	MSB
10	Enroute Operational Capabilities (CC-4)
11	
12	LSB
13	MSB
14	Terminal Area Operational Capabilities(CC-3)
15	
16	LSB
17	MSB
18	Approach/ Landing Operational Capabilities (CC-2)
19	
20	LSB
21	MSB
22	Surface Operational Capabilities (CC-1)
23	
24	LSB
25	MSB
26	Enroute Operational Capability Status (OM –4)
27	
28	LSB
29	MSB
30	Terminal Area Operational Capability Status (OM-3)
31	
32	LSB
33	MSB
34	Approach/ Landing Operational Capability Status (OM-2)
35	
36	LSB
37	MSB
38	Surface Operational Capability Status (OM-1)
39	
40	LSB
41	
42	
43	
44	
45	
46	
47	Not Assigned
48	
49	
50	
51	
52	
53	
54	
55	
56	

Purpose. To provide the capability class and current operational mode of ATC related applications on board the aircraft.